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NATIONAL MARINE FISHERIES SERVICE

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December 17, 1998

MEMORANDUM FOR: F/NW – William Stelle
F/SW – William Hogarth

THRU: F/NWC – Usha Varanasi

FROM: F/NWC3 – Michael H. Schiewe

SUBJECT: Conclusions regarding the updated status of Ozette Lake and Baker River ESUs of West Coast Sockeye Salmon

The Biological Review Team (BRT) for the west coast sockeye salmon status review met in Seattle on 4 November 1998 to discuss new information received regarding status of two evolutionarily significant units (ESUs) that earlier this year were proposed for listing under the Endangered Species Act (ESA). The BRT concluded that one ESU (Ozette Lake sockeye salmon) remains at risk of becoming endangered in the foreseeable future if present conditions continue, and that one other ESU (Baker River sockeye salmon) remains not presently at risk. The Baker River ESU had been identified by NMFS as a candidate species for possible listing in the future. Time constraints did not allow the BRT to review the ESA status of those sockeye salmon ESUs previously determined to be not at risk or other sockeye salmon population units of uncertain ESU status (riverine-spawning and Deschutes River, Oregon sockeye salmon).

Attached is the BRT report "Status Review Update for Sockeye Salmon from Ozette Lake and Baker River, Washington." This report presents BRT conclusions concerning ESU delineation and risk assessment for Ozette Lake and Baker River sockeye salmon. This report also summarizes comments on the 1997 status review and new scientific information received, for all ESUs and populations of sockeye salmon in Washington and Oregon, from co-managers, peer-reviewers, and others. The final section of this document presents information on sockeye salmon hatchery stocks in the Ozette Lake ESU, comments received from co-managers, and conclusions of the BRT on hatchery stock issues.

Please contact either Dr. Robin Waples or myself if you have any questions about this report.

Attachment

cc: F/PR - Hilda Diaz-Saltero
F/NWO - Donna Darm
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Status Review Update for Sockeye Salmon from Ozette Lake and Baker River, Washington

Prepared by the
West Coast Sockeye Salmon Biological Review Team*

DRAFT: 17 December 1998

* The biological review team (BRT) for the updated status review for West Coast Sockeye Salmon included Thomas Flagg, Dr. Richard Gustafson, Dr. Robert Iwamoto, Dr. Conrad Mahnken, Gene Matthews, Dr. Michael Schiewe, Dr. Thomas Wainwright, Dr. Robin Waples, Laurie Weitkamp, Dr. John Williams, and Dr. Gary Winans, all from the NWFSC.

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INTRODUCTION

On 10 March 1998, the National Marine Fisheries Service (NMFS) published a federal register notice describing six evolutionarily significant units (ESUs) within the range of west coast sockeye salmon from the states of Washington, Oregon, and California (NMFS 1998). The notice included a proposed rule to list one ESU as threatened under the U.S. Endangered Species Act (ESA) and to propose one ESU as a candidate for listing (Table 1). (An earlier action had identified a sockeye salmon ESU in the Snake River Basin, Idaho, which is currently listed as an endangered species.) This proposal was largely based upon the status review conducted by the west coast sockeye salmon biological review team (BRT) convened by NMFS (Gustafson et al. 1997), but also included consideration of conservation measures not addressed by the BRT.

The BRT met on 4 November 1998 to discuss comments and new data received in response to the proposed rule to determine if the new information warranted any modification of the conclusions of the original BRT. This report summarizes new information and the final BRT conclusions on the following ESUs: Ozette Lake and Baker River, both in Washington State. Updated information for other sockeye salmon ESUs and populations is included for comparison only. No effort was made to obtain complete updated information for populations not proposed for listing or in candidate status.

BACKGROUND INFORMATION

In March 1994, NMFS received a petition seeking protection under the ESA for Baker River sockeye salmon (anadromous *Oncorhynchus nerka*). At about the same time, NMFS received several other petitions for other populations of Pacific salmon in Washington, Oregon, Idaho, and California. In response to these petitions and to more general concerns for the status of Pacific salmon throughout the region, NMFS (1994) initiated ESA status reviews for all species of anadromous salmonids in the Pacific Northwest. The results of the status review for sockeye salmon was published in Gustafson et al. (1997). Subsequent to the status review, NMFS (1998) proposed listing Ozette Lake sockeye salmon as a threatened species under the ESA, and classified Baker River sockeye salmon as a candidate for listing. This status review update considers new information for those two populations received since the original status review, and considers technical comments received regarding the status review and listing proposal.

The ESA allows listing of "distinct population segments" of vertebrates as well as named species and subspecies. The policy of NMFS on this issue for anadromous Pacific salmonids is that a population will be considered "distinct" for purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the species as a whole. To be considered an ESU, a population or group of populations must 1) be substantially reproductively isolated from other populations, and 2) contribute substantially to the ecological or genetic diversity of the biological species.

Once an ESU is identified, a variety of factors related to population status are considered in determining the degree of extinction risk it faces (Gustafson et al. 1997). The BRT has been asked to evaluate available scientific information for each ESU and to determine whether 1) it is presently in danger of extinction throughout all or a significant portion of its range or 2) it is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. Following this evaluation by the BRT, other factors (e.g. adequacy of existing conservation measures) are considered by NMFS before deciding whether conditions warrant listing an ESU under the Endangered Species Act.

The conclusions from the original status review (Gustafson et al. 1997) are briefly presented below.

Summary of Previous Conclusions

After considering available information on genetics, phylogeny and life history, freshwater ichthyogeography, and environmental features that may affect sockeye salmon, the BRT identified 6 ESUs and one provisional ESU. The BRT reviewed population abundance data and other risk factors for these ESUs and concluded that one (Ozette Lake) was likely to become endangered in the foreseeable future, and that the remaining ESUs (Okanogan River, Lake Wenatchee, Quinault Lake, Baker River, and Lake Pleasant) were not presently in significant danger of becoming extinct or endangered, although there were substantial conservation concerns for some of these. Specific conclusions for the two ESUs considered here (Ozette Lake and Baker River) follow.

Ozette Lake ESU--This ESU consists of sockeye salmon that return to Ozette Lake through the Ozette River and currently spawn primarily in lakeshore upwelling areas in Ozette Lake (particularly at Allen's Bay and Olsen's Beach). Minor spawning may occur below Ozette Lake in the Ozette River or in Coal Creek, a tributary to the Ozette River. Sockeye salmon do not presently spawn in streams flowing into Ozette Lake (recent spawning in Umbrella Creek has been observed subsequent to stocking efforts), although they may have spawned there historically. Genetic, environmental, and life history information were the primary factors in distinguishing this ESU. The BRT felt that Ozette Lake sockeye salmon were a separate ESU based on the degree of genetic differentiation from other sockeye salmon populations and on life history characteristics.

Kokanee are very numerous in Ozette Lake and spawn in inlet tributaries, whereas sockeye salmon spawn on lakeshore upwelling beaches. Ozette Lake kokanee proved to be the most genetically distinct *O. nerka* stock examined in the contiguous United States (based on 29 allozyme loci) (Gustafson et al. 1997). Sockeye salmon have not recently been observed on the inlet spawning grounds of kokanee in the Ozette Lake Basin, although there are no physical barriers to prevent their entry into these tributaries. On the other hand, kokanee-sized *O. nerka* are observed together with sockeye salmon on the sockeye salmon spawning beaches at Allen's Bay and Olsen's Beach. Based on the large genetic distance between Ozette Lake kokanee and Ozette Lake sockeye salmon, the BRT excluded Ozette

Lake kokanee from this sockeye salmon ESU. In addition, the BRT concluded that if "kokanee-sized" *O. nerka* observed spawning with sockeye salmon on sockeye salmon spawning beaches in Ozette Lake are identified as resident sockeye salmon, then they are to be considered as part of the Ozette Lake sockeye salmon ESU.

Perceived risks for this ESU ranged from low to moderate for genetic integrity and variable ocean productivity, from low to moderate and increasing for downward trends and population fluctuations, and from moderate to increasing for abundance considerations. Escapements averaging below 1,000 adults per year were interpreted as implying a moderate degree of risk from small-population genetic and demographic variability, with little room for further declines before abundances would be critically low. Other concerns included siltation of beach spawning habitat, very low abundance compared to harvest in the 1950s, and potential genetic effects of present hatchery production and past interbreeding with genetically dissimilar kokanee. The BRT concluded that the Ozette Lake sockeye salmon ESU is not presently in danger of extinction, but if present conditions continue into the future, it is likely to become so in the foreseeable future.

Baker River ESU--This ESU consists of sockeye salmon that return to the barrier dam and fish trap on the lower Baker River after migrating through the Skagit River. Adults are trucked to one of three artificial spawning beaches above either one or two dams on the Baker River, and are held in these enclosures until spawning. Recently, significant numbers of sockeye salmon adults have been released into Baker Lake to spawn naturally. The BRT felt that Baker River sockeye salmon are a separate ESU based on genetic, life history, and environmental characters. Baker River sockeye salmon are genetically distinct from sockeye salmon populations that spawn in the lower Fraser River (allozyme data based on 9 loci) and are genetically distinct from all other native populations of Washington State sockeye salmon (allozyme data based on 29 loci).

The BRT had several concerns about the overall health of this ESU, focusing on high fluctuations in abundance, lack of natural spawning habitat, and the vulnerability of spawning beaches to water quality problems. Large fluctuations in abundance were a substantial concern. It is also likely that this stock would go extinct if present human intervention were halted, and problems related to that intervention pose some risk to the population. In particular, the BRT concluded that the proposed change in management to concentrate spawning in a single spawning beach could substantially increase risk to the population. There was considerable disagreement regarding the risks associated with several factors for this ESU. For example, the assessment of perceived risk for abundance and habitat capacity ranged among BRT members from very low to high, and classifications for risks related to water quality and disease also had wide ranges. The majority of the BRT concluded that the Baker River sockeye salmon ESU is not presently in danger of extinction, nor is it likely to become endangered in the foreseeable future if present conditions continue. A minority concluded that this ESU is likely to become endangered in the foreseeable future, largely on the basis of lack of natural spawning habitat and the vulnerability of the entire population to problems in artificial habitats.

West Coast Sockeye Salmon Proposed Rule

On 10 March 1998, NMFS published a proposed rule to list the Ozette Lake ESU as threatened under the ESA, and to place the Baker River ESU on the candidate species list (NMFS 1998). The proposed rule largely followed the findings of the BRT with regard to ESU boundaries and risk assessment, with some exceptions noted below.

Although the BRT was divided on the ESU status of sockeye salmon that currently spawn in Big Bear Creek in the Lake Washington Basin, this population was defined by the BRT as a provisional ESU. Despite the lack of unambiguous historical information, about half of the BRT felt that the current sockeye salmon population in Big Bear Creek is a separate ESU that represents either an indigenous Lake Washington/Lake Sammamish sockeye salmon population or a native kokanee population that has naturally re-established anadromy. About half the members felt that the available information was insufficient to determine the ESU status of sockeye salmon in Big Bear Creek. The proposed rule interpreted this finding to indicate that "the Bear Creek sockeye salmon population unit did not meet the criteria necessary to be defined as an ESU."

Although the BRT had several concerns about the overall health of the Baker River ESU, focusing on high fluctuations in abundance, lack of natural spawning habitat, and the vulnerability of spawning beaches to water quality problems, the majority of the BRT concluded that the Baker River sockeye salmon ESU is not presently in danger of extinction, nor is it likely to become endangered in the foreseeable future if present conditions continue. However, because of lack of natural spawning habitat and the vulnerability of the entire population to problems in artificial habitats, NMFS proposed to add the Baker River ESU to the list of candidate species.

TECHNICAL COMMENTS

Comments on the status review (Gustafson et al. 1997) and proposed rule (NMFS 1998) were received from a variety of federal, state, and tribal agencies (Table 2) as well as peer review comments solicited and received from two academic scientists familiar with the species.

General Comments

ESU Delineation

Several (not ESU-specific) comments about sockeye salmon ESU delineations were received. The Northwest Indian Fisheries Commission (NWIFC; Grayum 1998) states that the sockeye salmon status review is incomplete because it is limited to the anadromous form only and does not include designation of kokanee ESUs. Similarly, Brannon (1998) strongly expressed the opinion that kokanee should be made a part of any designated sockeye salmon

ESUs. The Columbia River Inter-Tribal Fish Commission (CRITFC; Strong 1998) presented general criticism of NMFS' ESU concept, arguing that the ESA does not require a Distinct Population Segment (DPS) to be reproductively isolated from other conspecific populations, that it is not possible to determine evolutionary significance of an ESU with genetic data, and that the ESU concept does not properly address the ecological significance of a DPS.

Although recognizing the observed genetic differentiation of sockeye salmon in Washington as shown by allozyme data, Wood (1998) stated that his unpublished analysis of mtDNA haplotype data for several populations of sockeye salmon in Washington does not, in general, support the "decision to define ESUs at the lake level."

Risk Assessment

A few general (not ESU-specific) comments about risk assessments were received, all from tribal agencies. The NWIFC (Grayum 1998) argued that status assessments should include kokanee as well as anadromous sockeye salmon, but agreed with the BRT conclusions regarding risk. The Yakama Nation (Selam 1998) specifically chose to remain silent about whether any of the ESUs should be listed under the ESA, but offered many comments specific to Columbia Basin salmon management issues. The Columbia River Inter-Tribal Fish Commission (Strong 1998) offered the strongest general criticism of NMFS' risk assessment approach, arguing that the BRT's evaluation of risks from artificial propagation was arbitrary, and that the overall risk assessment is fundamentally flawed because of an absence of references to standard conservation biology literature (particularly that on risk assessment methods), lack of unambiguous criteria for risk, no use of quantitative population modeling, and use of subjective opinion within the risk matrix approach.

ESU-Specific Comments

ESU Delineation

Ozette Lake—The majority of comments received pertain to this ESU, both from peer reviewers and other commenters. Brannon (1998) concurred with the designation of Ozette Lake sockeye salmon as a separate ESU; however, he emphasized his belief that Ozette Lake kokanee should be made part of the ESU, despite their very large genetic distance from beach-spawning Ozette Lake sockeye salmon. Brannon (1998) criticized the BRT for not recognizing the "role [of kokanee] in recovery of the anadromous form," and stated that given sufficient time and selective pressures, Ozette Lake kokanee will reintroduce the anadromous form of *O. nerka* to Ozette Lake. Wood (1998) agreed with both the separate ESU designation for Ozette Lake sockeye salmon and with the exclusion of kokanee from this ESU, based on information presented in the status review. Wood (1998) also provided additional data on genetic relationships of the Ozette Lake ESU to selected *O. nerka* populations in Washington and British Columbia based on unpublished mtDNA data. These data are summarized below in the "New Information Received" section.

Van Duzer (1998), commenting on behalf of Green Crow Timber, questioned the genetic integrity of the Ozette Lake sockeye salmon ESU and thus its designation as a separate species under the ESA. Based on the introduction of non-native sockeye salmon (Quinault Lake sockeye salmon were stocked in 1982) and sockeye salmon/kokanee hybrids (released in 1991 and 1992), Van Duzer (1998) stated that at "issue is whether the non-native population has bred with the native population to such an extent that the evolutionarily important adaptations that distinguished the original population have been lost." Van Duzer (1998) suggested that more research is needed to better determine the proper limits of the Ozette Lake sockeye salmon ESU before discrete ESU status is assigned.

Baker River--No comments specific to the delineation of Baker River sockeye salmon as an ESU were received.

Other populations--The NWIFC (Grayum 1998) disagreed with the BRT's designation of Big Bear Creek sockeye salmon as a provisional ESU. Grayum (1998) stated that sufficient supporting evidence is not available that would show this population to be a distinct native population. Wood (1998) presented results from mtDNA analysis of putative river-type sockeye salmon in the Nooksack, Skagit, and Sauk Rivers (summarized below in the "New Information Received" section), which taken together with previously reported allozyme data (Gustafson et al. 1997) struck him "as compelling evidence that these river-type sockeye salmon should be regarded as an ESU, separate from the lake populations in Washington State."

Risk Assessment

Ozette Lake--As with ESU delineation comments, the majority of risk assessment comments received pertain to this ESU, both from peer reviewers and other commenters. Among the peer reviewers, Wood (1998) concurred with the BRT risk evaluation, while Brannon (1998) disagreed. Despite his concurrence with the conclusion, Wood questioned the consistency of statements regarding siltation in tributaries as a cause of sockeye salmon decline compared to statements regarding abundance of kokanee, which would also presumably be affected by such siltation. Brannon raised five primary points in his argument that listing is not warranted for this ESU:

1) The dominant broodyears in the four-year abundance cycle (1984-88-92-96) are stable, not declining.

2) Risk is decreasing, not increasing, so becoming endangered in the future is not likely. As evidence of decreasing risk, he noted that the lake is protected within Olympic National Park, the watershed is recovering from logging in the 1950s, lake rearing habitat is not limiting, and there is no longer any tribal harvest. In addition, a review panel was unable to determine which factors were responsible for any decline in Ozette Lake sockeye salmon.

3) Tributary habitat loss has restricted sockeye salmon to lakeshore spawning areas. Recolonization of tributaries is not straightforward, so recovery will depend primarily on lakeshore spawning. There is no evidence that beach spawning habitat is not fully utilized.

4) Siltation of beach spawning habitat is not sufficient reason for listing. There is no evidence of beach degradation over the last 40 years, and rearing habitat has probably improved.

5) Genetic effects of hatchery production are misrepresented in the status review. Kokanee should be included as part of the ESU, and are essential to re-establish tributary-spawning sockeye salmon. Kokanee represent the remaining tributary-spawning gene pool, and without them anadromous production will not expand beyond what the limited beach habitat can produce.

Only one public agency commented specifically on risk for this ESU--the U.S. Department of the Interior concurred with the conclusion that Ozette Lake sockeye salmon warrant listing as threatened.

Two forest resource companies commented on the proposal to list Ozette Lake sockeye salmon: Rayonier Northwest Forest Resources (Meier 1998) and Green Crow Timber (Gladders 1998; Rochelle 1998; Van Duzer 1998). Northwest Forest Resources focused on interpretation of population trends, arguing that the main decline in abundance occurred between 1948 and 1958, and that populations have not declined substantially since then. They noted that declines cited by the BRT were not statistically significant, and that an analysis of the four individual brood cycles (4-year lags) shows two increasing and two declining. They also provided new information on the history of logging in the Ozette Basin (discussed under Population Trends and Production below), noting that the main population declines occurred before there was substantial logging in the basin. Green Crow Timber (Gladders 1998) raised similar points: there is a consistent strong run every four years indicating that the population is no longer declining significantly, overharvest at sea could be a major limiting factor, logging was a minor factor, tributary spawning may have been eliminated by harvest practices focusing on the early part of the run, and re-establishment of tributary spawning by anadromous fish is limited by the genetics of remaining lake-spawning fish. Other comments on behalf of Green Crow re-iterated some of these points: that the population has stabilized over the last 40 years (Van Duzer 1998) and that overharvest is a more likely cause of decline than is logging (Rochelle 1998).

Baker River--Of the peer reviewers, only Brannon (1998) commented on the Baker River ESU. Brannon gave 5 arguments why this ESU should not be a candidate for listing:

1) Because the Baker Lake spawning beaches are essentially a hatchery, this is not a natural stock, and therefore is not subject to the ESA.

2) Abundance and trends do not demonstrate high risk.

3) Concentrating spawning in Beach 4 only is not a risk. Beaches 2 & 3 are subject to washout in floods, and can't be relied on in the long-term. Beach 4 is highly productive, producing very high numbers of fry per female.

4) Water quality and disease are not a serious concern at Beach 4.

5) Human interventions may pose a risk to long-term evolution of the population, but will be required for the run to continue. Listing and development of a recovery plan would produce nothing better than the status quo.

Only one other comment related to risk of this ESU was received. Puget Sound Energy (Feldmann 1998) agreed with the BRT conclusion that an ESA listing is not warranted, but disagreed with the BRT's interpretation of historical abundance data, particularly NMFS's statement that escapements averaged 20,000 near the turn of the century. They cited escapement estimates from hatchery egg and adult counts indicating an average escapement of about 5,000 for the period 1896-1925, with a peak escapement of about 14,600 fish in 1924.

Other populations--Three commenters discussed other sockeye salmon ESUs. Rayonier Northwest Forest Resources (Meier 1998) agreed with the BRT conclusion regarding risks to the Lake Pleasant ESU. CRITFC (Strong 1998) disagreed with the BRT's conclusion that the Okanogan River and Lake Wenatchee ESUs are near historic levels. They cited evidence that total Columbia Basin sockeye salmon run size may have exceeded 4,000,000 fish at a time when the Okanogan Basin had 41% of the accessible lake rearing area in the Columbia Basin, and suggest that historical Okanogan River escapement was probably in excess of 1,000,000 fish, not the 12,000 fish suggested in the status review. Further, they commented that the Wenatchee stock is of particular concern, with a recent steep decline and very low escapements despite negligible downstream harvest. The Okanogan stock has also exhibited a steep recent decline, and both stocks have poor prospects for 1999 runs. Although disagreeing with the designation by the BRT of Big Bear Creek sockeye salmon as a separate ESU, NWIFC (Grayum 1998) concurred with the risk assessment conclusions concerning this population.

NEW INFORMATION RECEIVED

Ozette Lake–Wood (1998) reported variation in the cytochrome *b* and ND1 regions of mitochondrial DNA (mtDNA) for 20 samples each of Ozette Lake sockeye salmon (Olsen's Beach) and kokanee (Crooked Creek) supplied by NMFS. Composite haplotypes for 19 sockeye salmon and 14 kokanee were successfully determined. Genetic differences between Ozette Lake sockeye salmon and kokanee were highly significant statistically; sockeye salmon samples were fixed for a single haplotype, whereas the kokanee samples exhibited this same haplotype plus two additional haplotypes. One of these latter haplotypes was predominant in kokanee samples. Wood (1998) stated that "there can be little doubt that the Ozette sockeye population (as sampled) is or has been reproductively isolated from the kokanee sampled in Crooked Creek." On the other hand, when Wood (1998) compared the same mtDNA composite haplotypes from Ozette Lake sockeye salmon to Quinault Lake and Cedar River sockeye salmon, there was little or no difference. Wood's (1998) other five sockeye salmon samples from Washington (Osoyoos Lake, Lake Wenatchee, Nooksack River, Sauk River, and Skagit River) did not closely resemble the Ozette Lake, Quinault Lake and Cedar River samples, suggesting to Wood that these latter populations may represent a separate lineage of southern, coastal sockeye salmon.

Baker River–Blakley and Volk (1998) studied strontium/calcium ratios (SR/CA) in otolith cores from sockeye salmon/kokanee taken in the sport fishery in 1996 in Baker Lake;

from sockeye salmon smolts captured in the Baker Lake smolt trap, and from adult sockeye salmon returning to Baker Lake. High Sr/Ca (indicative of maternal saltwater residence) were found in nearly all fish taken in the fishery and in the smolt trap, as well as in sockeye salmon adults, leading Blakley and Volk (1998) to conclude that most of the fish caught in the sport fishery in Baker Lake are sockeye salmon that have residualized in Baker Lake due to the low smolt-trap efficiency. Efforts are underway to analyze natural strontium chemistry of Baker Lake, in order to verify the above results (A. Blakley, pers. comm.).

Riverine-spawning sockeye salmon--NMFS evaluated data from literature sources (Guthrie et al. 1994; Wood et al. 1994; Winans et al. 1996; Waples et al. 1997) and from NMFS unpublished data for 9 polymorphic allozyme loci from 12 North American populations that were identified as river-/sea-type sockeye salmon and for a representative sampling of 26 lake-type sockeye salmon (Fig. 1 and Table 3). All samples of river-/sea-type sockeye salmon from Puget Sound, Washington in the south to the Chilkat River in northern Southeast Alaska (Nos. 27-37), a range of over 2000 aquatic kilometers, were genetically closely related (Figs. 2 and 3). River-/sea-type sockeye salmon from the East Alsek River (No. 38) on the Yakutat Forelands of extreme Southeast Alaska did not cluster tightly together with other populations of river-/sea-type sockeye salmon. This result may be due to the recent (1960s) origin of the East Alsek River population (Halupka et al. 1993). In contrast to the genetic similarity of the river-/sea-type samples (Nos. 27-37), there was considerable heterogeneity among samples of both northern and southern lake-type sockeye salmon groups. For example, among the Olympic Peninsula samples, Lake Pleasant (No. 4), Ozette Lake (No. 5), and Quinault Lake (No. 6) were dissimilar, despite being within 180 aquatic kilometers of one another (Figs. 1 and 2). Similar patterns of variation were seen in a dendrogram (Fig. 3), in which Redfish Lake branched from the two major clusters of sockeye salmon, and East Alsek River, Weaver Channel, and Ozette Lake were outliers of their respective geographic or life-history groupings. The relationship between geographic distance between populations and their genetic relatedness is shown in Figure 4. Even with geographic distances between populations as great as 2000 aquatic kilometers, river-/sea-type populations on the Pacific Coast of North America remain genetically similar, whereas there is no apparent relationship between geographic distance and genetic distance over the same range for lake-type sockeye salmon or for the comparison between lake-type and river-/sea-type sockeye salmon.

Wood (1998) reported that mtDNA composite haplotypes showed little variation among samples of putative river-type sockeye salmon from the Nooksack, Skagit and Sauk Rivers in Puget Sound, but that these populations were very distinct from other sockeye salmon populations in Washington and in the Fraser River. The Nooksack, Skagit, and Sauk River samples contained a high frequency (>0.33) of haplotype 5, which is typically found in northern B.C. and Alaskan sockeye salmon (Wood 1998). Haplotype 5 has been found in only four other sites in southern B.C.: Sprout and Great Central Lakes and in river-type sockeye salmon from the Zeballos and Leiner Rivers, all on Vancouver Island (Wood 1998).

SUMMARY AND CONCLUSIONS OF ESU DETERMINATIONS

In the 4 November 1998 meeting, the Biological Review Team discussed the comments and new information received since the proposed rule and re-evaluated the decisions of the original BRT regarding sockeye salmon ESU determinations for Ozette Lake and Baker River. Key elements of the BRTs discussion are summarized below.

Discussion and BRT Conclusions on Kokanee

The BRT reviewed the available information concerning the relationship of sockeye salmon and kokanee and concluded that there was insufficient reason to change the previous conclusions of the BRT. These previous conclusions are summarized below.

The BRT previously defined "kokanee" as the self-perpetuating, nonanadromous form of *O. nerka* that occurs in balanced sex-ratio populations and whose parents, for several generations back, have spent their whole lives in freshwater. The terms "residual sockeye salmon" and "residuals" have been used to identify resident, non-migratory progeny of anadromous sockeye salmon. In considering the ESU status of resident forms of *O. nerka*, the key issue is evaluating the strength and duration of reproductive isolation between resident and anadromous forms. Many kokanee populations appear to have been strongly isolated from sympatric sockeye salmon populations for long periods of time. Since the two forms experience very different selective regimes over their life cycle, reproductive isolation provides an opportunity for adaptive divergence in sympatry. Kokanee populations that fall in this category will generally not be considered part of sockeye salmon ESUs. On the other hand, resident fish appear to be much more closely integrated into some sockeye salmon populations. For example, in some situations anadromous fish may give rise to progeny that mature in freshwater (as is the case with residual sockeye salmon), and some resident fish may have anadromous offspring. In these cases, where there is presumably some regular or at least episodic genetic exchange between resident and anadromous forms, they should be considered part of the same ESU.

Discussion and BRT Conclusions for Specific ESUs

Ozette Lake-- The BRT reviewed new mitochondrial DNA (mtDNA) haplotype and allozyme genetic evidence pertaining to sockeye salmon population structure in Washington State, and in particular Ozette Lake, and found insufficient reason to change its previous conclusions concerning ESU structure. Composite haplotype frequencies for mitochondrial cytochrome *b* and ND1 genes in sockeye salmon and kokanee samples from Ozette Lake (Wood 1998) corroborated the allozyme genetic evidence that Ozette Lake kokanee and sockeye salmon are genetically distant from one another. Additional allozyme data from adult kokanee in Crooked Creek (a tributary of Ozette Lake) also agreed with earlier results derived from allozymes for Siwash Creek (a tributary of Ozette Lake) kokanee.

The BRT also considered new mtDNA haplotype data indicating little divergence between Quinault Lake and Ozette Lake sockeye salmon (Wood 1998). These data were contrasted to earlier allozyme data, based on 29 loci, that showed Ozette Lake sockeye salmon to be genetically distinct from all other sockeye salmon populations in the Northwest. The BRT concluded that, since mtDNA is essentially a single "gene locus" (from a phylogenetic perspective), these data were not sufficiently compelling to change the BRTs previous conclusion to define coastal sockeye salmon ESUs at the lake level.

Other populations– In the 4 November 1998 meeting, the BRT did not address ESU delineation questions for populations or ESUs of sockeye salmon other than Ozette Lake and Baker River.

DISCUSSION OF EXTINCTION RISK FACTORS

In this section, we discuss important new information and analyses for two risk factors (population abundance, and population trends and production) for the two ESUs under consideration. No new information regarding other factors considered in the original status review (hatchery production, genetic risks, and habitat conditions) was received. The following sections summarize new information and conclusions regarding the degree of extinction risk facing each ESU based on this new information as well as that in Gustafson et al. (1997).

Population Abundance

New information received since the status review is described in Table 4. Updated population abundance data for all ESUs and other populations are summarized in Table 5.

Ozette Lake–Adult migrant abundance data for years since the status review was published in 1997 were obtained from the Makah Tribe (M. Crewson, Makah Indian Tribe, pers. comm., 21 August 1998). Five-year average (geometric mean) estimated abundance for the period 1994-1998 was 580, slightly below the average of 700 reported by Gustafson et al. (1997). This decrease is largely because the earlier average included two dominant brood-cycle years, while the recent average includes only one. The 1998 count of 984 was substantially above the count of 498 that was observed 4 years (one generation) earlier. This may result primarily from a change in counting methods; a video camera was installed in 1998 and the operation period of the weir was expanded (7 May - 14 August), resulting in a more complete count of all fish passing the weir (M. Crewson, Makah Indian Tribe, pers. comm., 21 August 1998). It is likely that counts for previous years underestimated total spawner abundance, but the magnitude of this bias is unknown.

Baker River--Spawner abundance data for years since the status review was published in 1997 were obtained from Washington Department of Fish and Wildlife (Sprague 1998). Five-year average estimated abundance for 1994-1998 was 7,600, a substantial increase from the average of 2,700 reported by Gustafson et al. (1997). The 1998 escapement of 13,200 was the second highest since counts at the dam site began in 1926, exceeded only in 1994. Earlier estimates based on hatchery records dating to 1895 indicate a peak escapement of 20,000 in 1895 (WDFW 1996), but averaged only about 5,000 between 1895 and 1925. The 1994-1998 average is the highest for any 5-year period for which we have data.

Other populations--We have obtained updates of adult escapement for all other sockeye salmon ESUs (Fish Passage Center 1998; J. Ames, WDFW, pers. comm., 20 August 1998; D. Boyer, Quinault Indian Nation, pers. comm., 24 August 1998), and several other populations (E. Warner, Muckleshoot Indian Tribe, pers. comm., 31 August 1998). Of these populations, only three had substantial changes in 5-year average abundance since the status review. There were steep declines in the Lake Wenatchee (19,000 to 6,300) and Okanogan River (11,100 to 7,000) ESUs, and an increase in the Cedar River population (67,500 to 84,700).

Comments from CRITFC regarding historical abundance of Columbia River sockeye salmon may be accurate, but it is not clear how to relate estimates of early basin-wide abundance to presently existing ESUs and populations. It is clear that much production has been lost, much of it in populations that have been extirpated. Based on dam-passage records, Gustafson et al. (1997) noted that average escapements to the Okanogan and Wenatchee ESUs combined were low (below 20,000) in the 1930s and early 1940s and higher (above 100,000) in the 1950s; individual estimates for the two ESUs were not possible until the 1960s. However, these two ESUs have dominated basin-wide production since at least 1960, and current production of these ESUs is well below peak run sizes at the mouth of the Columbia River that approached 200,000 in the late 1960s and again in the mid-1980s.

Population Trends and Production

New information received since the status review is described in Table 4. Updated population trend and production data for all ESUs and other populations are summarized in Table 5.

Ozette Lake–Updated analysis of trends indicates that the short-term (10-year) trend has improved from a decline of 9.9% per year in Gustafson et al. (1997) to a relatively low 2% annual increase (Fig. 5). How much this is influenced by the change in counting methods in 1998 is not known. The long-term trend remains slightly downward (-2%).

In addition to updated abundance data, we have received an analysis of logging history in the Ozette Basin from Rayonier Northwest Forest Resources (Meier 1998). This analysis indicates that most logging in the basin occurred since the mid-1950s: in 1953, only 8.7% of the basin had been logged, while 60% had been logged by 1981. Thus, logging occurred largely after the substantial decline in sockeye salmon catch in the early 1950s.

Baker River--Based on updated abundance figures (Fig. 6), the 10-year population trend for the Baker River ESU is somewhat more strongly upward now (37.7% annual increase) than it was at the time of the status review (31.6% annual increase; Gustafson et al. 1997). The full data series trend remains slightly downward. In addition to adult abundance, WDFW provided estimates of outmigrating smolts for the years 1993-1998 (G. Sprague, pers. comm., 21 August 1998). From a low of about 26,000 in 1993, smolts increased to a peak of 191,000 in 1996, then declined to 92,000 in 1998. The 50% decline in smolts from 1996 to 1998 suggests that adult population returns may soon decline as well (if a constant smolt-to-adult return rate exists).

The main risk factors of concern to the BRT were not related to population numbers, but rather the risks of artificial management of the population. Since the 1997 status review, several aspects of management have changed (G. Sprague, WDFW, pers. comm.). Net pen culture of a portion of the juvenile sockeye salmon coming out of the lower spawning beach (Beach #4) has been discontinued due to continuing problems with the virus causing infectious hematopoietic necrosis (IHN). The lower spawning beach, Beach 4, has been partitioned into 4 sections to try to isolate IHN outbreaks; however, this has proved ineffective as IHN has been transmitted through the partitioning material. Currently, the two upper spawning beaches are stated to be in an "active mothball status" (G. Sprague, WDFW, pers. comm.). Normally, natural ground water pressure provides sufficient upwelling for operation of Beach 3; however, Beach 2 was abandoned because it required active pumping of water to provide sufficient upwelling for incubation and because of deterioration of the facility and lack of funds to provide maintenance. Beach 3 will accommodate up to 750 adult sockeye salmon, but in 1998 early mortality of over 300 fish due to low water flows and low dissolved oxygen levels caused managers to release the remaining adults to Channel Creek, which flows into Baker Lake. IHN outbreaks have not been detected in Beach 3.

Other populations--There are a few noteworthy changes in trends for other populations for which we received new information since the status review. In the Puget Sound area, the 10-year trend for the Cedar River sockeye salmon population improved from -18.2% to -8.2%, and that for Big Bear Creek increased from -4.1% to +11.3%. In the Columbia River Basin (Fig. 7), the 10-year trend for the Lake Wenatchee ESU declined from -9.8% to -21.1%, while that for the Okanogan River ESU improved from -19.9% to -8.2%.

SUMMARY AND CONCLUSIONS OF RISK ASSESSMENTS

Evaluation Methods

To tie the various risk considerations into an overall assessment of extinction risk for each ESU, the Biological Review Team (BRT) members scored risks in a number of categories using a matrix form, then drew conclusions regarding overall risk to the ESU after considering the results. The general risk categories evaluated included: abundance; trends, productivity and variability in abundance; genetic integrity; and "other risks". The summary of overall risk to an ESU uses categories that correspond to definitions in the Endangered Species Act: in danger of extinction, likely to become endangered in the foreseeable future, or not currently at significant risk. (Note, however, that these do not correspond to recommendations for a particular listing action because they are based only on past and present biological condition of the populations and do not contain a complete evaluation of conservation measures as required under the ESA for a listing determination.) The risk conclusions do not reflect a simple average of the risk factors for individual categories, but rather a judgement of overall risk based on likely interactions among, and cumulative effects of the different factors. For example, a single factor with a "high risk" score may be sufficient to result in an overall conclusion of "in danger of extinction," but such an overall determination could also result from a combination of several factors with low or moderate risk scores. Risk scores for the three main risk categories are summarized in Table 6.

The BRT used two methods to characterize the uncertainty underlying their risk evaluations. One way the BRT captured the levels of uncertainty associated with the overall risk assessments was for each member to attach a certainty score (1=low, 5=high) to their overall risk evaluation for each ESU. For example, a BRT member who felt strongly that an ESU was likely to become endangered in the foreseeable future (or not currently at significant risk) would vote for that category of risk and assign a certainty score of 4 or 5; if that member was less sure about the level of risk, a lower certainty score would be given to the risk vote.

The second method for characterizing uncertainty was one fashioned after an approach used by the Forest Ecosystem Management Assessment Team (FEMAT 1993), whereby each BRT member was given 10 total "likelihood" points to distribute in any way among the three risk categories. For example, a high level of confidence that an ESU should be in one risk category would be represented by most or all of the 10 points allocated to that category. Alternatively, if a BRT member was undecided about whether the ESU was likely to become endangered but felt the ESU was at some risk, they could allocate the same or nearly the same number of points into each of the "likely to become endangered" and "not likely to become endangered" categories. This assessment process follows well documented, peer-reviewed methods for making probabilistic judgements (references in FEMAT 1993 pp. IV-40-45). The BRT interpreted these scores similarly to the way they were used in the FEMAT process: ". . . the likelihoods are not probabilities in the classical notion of frequencies. They represented degrees of belief [in risk evaluations], expressed in a probability-like scale that could be mathematically aggregated and compared across [ESUs]" (FEMAT 1993 p. IV-44).

General Risk Conclusions

The two methods used by the BRT to characterize uncertainty in risk assessments generally were consistent in their outcomes. In the first method, the certainty scores for most ESUs were wide-ranging (in the range of 1 to 4), reflecting a fair amount of uncertainty regarding the conservation status of sockeye salmon in the ESUs evaluated. Results from the "FEMAT" method were generally concordant with and support information provided by the first method. That is, when the majority of BRT votes fell in a particular risk category, the majority of likelihood points also fell in the same category. For all ESUs, a small fraction of likelihood votes occurred in the "in danger of extinction" category. This result reflects the limited information available for conducting risk evaluations for sockeye salmon. Although in many cases available information did not provide conclusive evidence of high risk, it also did not clearly demonstrate that the ESUs were not at risk. As a result, at least some BRT members felt that they could not completely exclude the possibility that a particular ESU is presently in danger of extinction. However, when asked to pick only one risk category (the first method), in no cases did BRT members conclude that an ESU is presently in danger of extinction.

ESU-Specific Conclusions

Ozette Lake--The BRT concluded that the Ozette Lake sockeye salmon ESU is not presently in danger of extinction, but, if present conditions continue into the future, it is likely to become so in the foreseeable future. The uncertainty underlying this conclusion was moderate: certainty scores ranged from 2-4, with an average of 2.8, on a 5-point scale, and all BRT members placed a majority of likelihood points in the "likely to become endangered" category using the "FEMAT" voting method. However, all members also placed some weight in the "not presently at risk" category, and some members placed some weight in the "in danger of extinction" category. Main uncertainties arose from questions about the reliability of abundance estimates and the historical presence of river-spawning sockeye salmon in the basin.

Perceived risks were focused on low current abundance and trends and variability in abundance; risk scores ranged from 3 to 4 (on a 5-point scale) for both current abundance and trends, productivity, and variability, and from 2 to 3 for genetic integrity (Table 6). Current escapements averaging below 1,000 adults per year imply a moderate degree of risk from small-population genetic and demographic variability, with little room for further declines before abundances reach critically low levels. Other concerns include siltation of beach spawning habitat, very low abundance now compared to harvests in the 1950s, and potential genetic effects of past interbreeding with genetically dissimilar kokanee.

Baker River--The majority of the BRT concluded that the Baker River sockeye salmon ESU is not presently in danger of extinction, nor is it likely to become endangered in the foreseeable future if present conditions continue. A minority concluded that this ESU is likely to become endangered in the foreseeable future. It should be noted that the minority opinion does not reflect concern for present abundance or population trends, but rather the lack of natural spawning habitat and the vulnerability of the entire population to problems associated with human intervention in the life cycle. The uncertainty underlying this conclusion was moderate: certainty scores ranged from 1-4, with an average of 2.9 on a 5-point scale, and most BRT members placed a majority of likelihood points in the "not presently at risk" category. Main uncertainties and disagreements regarding status arose from questions about the degree of human interventions in the life-cycle, and whether this population should be considered naturally self-sustaining in light of these interventions.

The BRT had several concerns about the overall health of this ESU, focusing on high fluctuations in abundance, lack of natural spawning habitat, and the vulnerability of spawning beaches to water quality problems. Large fluctuations in abundance were a substantial concern. It is also likely that this stock would go extinct if present human intervention were halted, and problems related to that intervention pose some risk to the population. Previously, the BRT concluded that a proposed change in management to concentrate spawning in a single spawning beach could substantially increase risk to the population. This is still of concern to the BRT. Although one commenter on this ESU (Brannon 1998) argued that restriction of artificial spawning of adult sockeye salmon in this ESU to a single beach (Beach 4) was not a risk (see "ESU-Specific Risk Assessment Comments" section), the BRT concluded that IHN prevalence and potential for recurring siltation problems at Beach 4 (and lack of these disadvantages at the upper two beaches when fully maintained), coupled with planned elimination of the upper beach facilities, continues to pose a risk to this population.

Other populations--While other ESUs and populations were not extensively reviewed at this time, the BRT did review updated trend information for the Wenatchee and Okanogan ESUs, and the majority of BRT members expressed concern for the continuing low abundance in these ESUs and suggested that the status of these ESUs bear close monitoring.

HATCHERY POPULATIONS

If the Ozette Lake ESU is identified as threatened or endangered in the final listing determination, it will be necessary for NMFS to determine the ESA status of hatchery populations that are associated with the listed ESU. According to NMFS policy (NMFS 1993, see also Hard et al. 1992), two key questions must be addressed for each hatchery stock associated with a listed species: 1) Is it part of the ESU? And, if so, 2) Should the hatchery population be listed? The focus of these evaluations should be on "existing hatchery fish," which are defined in the policy to include prespawning adults, eggs, or juveniles held in a facility, as well as fish that were released prior to the listing but have not completed their life cycle.

The first question--the ESU status of existing hatchery populations--is a biological one, and the guiding principle should be whether the hatchery population contains genetic resources similar to those of natural populations in the ESU. The second question is an administrative one. According to NMFS policy, existing fish would generally not be listed even if they are part of the ESU unless they are considered "essential" for recovery (see discussion below).

To address the ESU question, the BRT considered information on stock histories and broodstock collection methods for existing hatchery populations associated with the ESU. Additionally, where available, the BRT considered genetic information on hatchery populations and their relationship to naturally spawning populations within and outside of the ESU. In evaluating the importance of hatchery stocks for recovery, the BRT considered the relationship between the natural and hatchery populations and the degree of risk faced by the natural population(s). Hatchery programs that have not recently produced sockeye salmon were not considered.

It is important to note two considerations with respect to the evaluations of hatchery populations. First, the BRT conclusions apply to individual hatchery stocks and not to facilities. Second, a determination that a stock is not "essential" for recovery does not preclude it from playing a role in recovery. Any hatchery population that is part of the ESU is available for use in recovery if conditions warrant. In this context, an "essential" hatchery population is one that is vital to the success of recovery efforts at the outset (for example, if the associated natural population(s) were already extinct or at high risk of extinction). Under these circumstances, NMFS would consider taking the administrative action of listing the existing hatchery population at the time of the final listing determination. Fish that are progeny of listed fish taken into a hatchery for broodstock automatically will be listed, so any hatchery population involved in formal recovery under the ESA eventually will be comprised of listed fish.

Oncorhynchus nerka Hatchery Stocks

Key information NMFS considers in evaluating the ESU status of hatchery populations includes stock histories and broodstock collection methods, both at present and in the past. Impacts of artificial propagation to specific river basins prior to and during the operation of the facilities are also considered. In some cases, although hatcheries obtained broodstock from local sources, the local population may already have been substantially changed due to previous introductions of non-native fish. As part of the process of evaluating the ESU status and importance of stocks for recovery, draft hatchery stock summaries were provided to co-managers for review. Both the BRT's stock summaries and comments received from the co-managers are summarized in this section.

Current hatchery *O. nerka* stocks being considered in this document include:

Ozette Lake sockeye salmon stock
    Umbrella Creek Hatchery
Ozette Lake sockeye salmon/kokanee hybrid stock
    Umbrella Creek Hatchery

Ozette Lake sockeye salmon stock--The Umbrella Creek incubation facility was established in 1982 by the Makah Fisheries Management Department to supplement the sockeye salmon run in Ozette Lake through incubating and rearing sockeye salmon for release into the Ozette Lake system. This hatchery is on land leased to the Makah Tribe by the forest industry and is currently located on a small tributary (WRIA #20.0056), just above its confluence with Umbrella Creek, approximately 7.2 river kilometers above Ozette Lake. Sones (1998) stated that egg collection goals for this program have been based on consideration of yearly adult abundance based on lake escapement estimates. The current egg capacity of the hatchery is 336,000 and no final numerical goals for egg take have been established (Sones 1998). The interim goal of this hatchery has been reported to be either the release of 250,000 fry (MFMD 1990; LaRiviere 1991) or the collection of 250,000 green eggs (Jacobs et al. 1996) per year. In the past, the goal of this hatchery was stated to be either the release of 3,000,000 sockeye salmon fry into Ozette Lake (MFMD 1990) or the collection of 3,000,000 green eggs (Jacobs et al. 1996) per year.

Broodstock collection, egg handling, and juvenile rearing procedures for sockeye salmon cultured at Umbrella Creek Hatchery have evolved over the years. Currently, ripe or nearly ripe broodstock are collected from the two remaining lakeshore spawning beaches (Allen's Bay and Olsen's Beach) using seines and gill nets in November through January. Broodstock are transported to the hatchery and held until they reach maturity (Jacobs et al. 1996). According to Sones (1998), adult broodstock from the two spawning beach populations have been spawned separately and their eggs incubated separately in every year from 1983 to the present, with the exception of broodyear 1991. In 1991, there was no effort to interbreed the two populations but they were not specifically segregated (Sones 1998).

According to Jacobs et al. (1996), the hatchery currently uses stacked vertical incubators, (Heath trays) and eyed eggs are transferred to a "Nopad" incubator. Fish are free to leave the incubators and move to a rearing tank, where they are fed. When they reach a target size of 400 fry per pound, the juveniles are transferred to a 100 gallon container and transported to Ozette Lake, or lake tributaries for release (Jacobs et al. 1996). In the past, lake releases of juveniles occurred in the limnetic zone in late June through July (Jacobs et al. 1996). Since 1994, all juvenile releases have occurred in lake tributaries (Umbrella and Crooked Creeks).

Juvenile sockeye salmon releases from the Umbrella Creek hatchery are summarized in Table 7. In 1983, approximately 120,000 Quinault Lake sockeye salmon fry of the 1982 brood-year were reared at this facility and released in Ozette Lake. Efforts since that time have centered on native, wild Ozette Lake sockeye salmon broodstock; although some sockeye salmon/kokanee hybrids were released in 1991 and 1992. In addition, sockeye salmon returning to the hatchery on Umbrella Creek in certain years (1991 and 1997) were also used as broodstock, although progeny of these fish were released in tributary locations. According to Sones (1998), "Only lake populations, reared separately, were ever released into the lake." Between 1984 and 1998, more than 1.1 million Ozette Lake-origin sockeye salmon fry were reared at Umbrella Creek Hatchery and released into the Ozette Lake drainage (MFMD n.d.; Sones 1998). Besides accidental releases into Umbrella Creek, sockeye salmon releases from this hatchery between 1987 and 1994 occurred primarily in Ozette Lake (Sones 1998). Since 1994, all releases have occurred in two tributaries, Umbrella Creek and Crooked Creek (see Table 7) (Sones 1998).

Specific efforts to document the proportion of supplemented fish returning to the spawning beaches have not been undertaken, although hatchery marked fish have been observed as spawned-out carcasses on the beaches (MFMD 1995). No straying to the beaches has been documented from the tributary releases to date (Sones 1998). Adult returns to Umbrella Creek have been observed in 1995, 1996, and 1997 (Sones 1998). According to

Jacobs et al. (1996), the Makah Tribe has considered expansion of the hatchery program but this has not occurred due to "policy and biological concerns of the tribe and the National Park Service centered around the hatchery concept, costs, and very limited availability of Lake Ozette broodstock."

Comments Received

The following two key question were asked of the co-managers: 1) Is this hatchery stock part of the ESU? And, if so, 2) Should the hatchery population be listed? Responses to these questions were received from the Makah Tribal Council (Sones 1998); the Quileute Indian Tribe (Moon 1998); Washington Department of Fish and Wildlife (WDFW) (Crawford 1998); and the U.S. Dept. of Interior, Olympic National Park (Hoffman 1998) and Fish and Wildlife Service (Badgley 1998). All of the above commenters were of the opinion that descendants of the sockeye salmon Umbrella Creek Hatchery stock should be part of the ESU, but were divided on the question of whether this hatchery stock is essential for recovery.

Sones (1998; Makah Tribal Council) stated that since broodstock of the Umbrella Creek Hatchery program are taken directly from the wild, they share identical genetic resources with wild members of the ESU and should be considered part of the ESU and essential for recovery. Sones (1998) argued that it is vital to use supplementation and reintroduction to the tributaries and to Ozette Lake to preserve the population. Similarly, Moon (1998; Quileute Indian Tribe) stated that the Umbrella Creek Hatchery stock "is genetically equivalent to the ESU ..." and "that hatchery stocks will play an essential role in the recovery of both lakeshore and tributary spawning sockeye populations in Lake Ozette." Crawford (1998; WDFW) stated that all anadromous sockeye salmon in the Ozette Lake drainage, including hatchery fish should be included in the ESU, and that "the anadromous hatchery population is an essential part of recovery."

Hoffman (1998; Olympic National Park) stated that "adult sockeye utilized in the Umbrella Creek Hatchery should be genetically similar to those in the natural populations and should be included in the ESU," but that in the absence of a rapid decline in the natural population, this stock should not be considered essential for recovery of lakeshore sockeye salmon populations. Similarly, Badgley (1998; Fish and Wildlife Service) stated that since broodstock for this program are obtained from the wild spawning area, "the hatchery stock is biologically part of the Lake Ozette ESU," but is not essential for recovery and "should not be listed with the naturally spawning population."

Ozette Lake sockeye salmon/kokanee hybrid stock--Over 14,000 sockeye salmon by kokanee hybrids derived from Ozette Lake beach spawning male sockeye salmon and Siwash Creek female kokanee were reared at the Umbrella Creek Hatchery and released in 1991 in Ozette Lake, near the mouth of Siwash Creek, and in 1992 in the Ozette River (Sones 1998). According to Jacobs et al. (1996), the Makah Tribe initiated this hybridization program in an attempt "to restore a tributary-spawning component of the sockeye run" using fish "with genetic characteristics native to the Ozette system" (LaRiveire 1991b). All releases of hybrid sockeye salmon and kokanee were given identifying fin clips. According to Jacobs et al. (1996), this program was discontinued in 1992 "because of poor survival of eggs and fry, concerns about genetic integrity of sockeye salmon and kokanee stocks in Ozette Lake, and concerns about the possibility of retarded saltwater adaptability of hybrid smolts as noted in studies conducted elsewhere by Foote et al. (1992)." As adult sockeye salmon returns to Ozette Lake are overwhelmingly 4-yr-olds, adult returns from this program would have been expected in 1995 and 1996. According to Sones (1998), no progeny of the program survived.

Comments Received

The following two key question were asked of the co-managers: 1) Is this hatchery stock part of the ESU? And, if so, 2) Should the hatchery population be listed? Responses to these questions were received from the Makah Tribal Council (Sones 1998); and the U.S. Dept. of Interior, Olympic National Park (Hoffman 1998) and Fish and Wildlife Service (Badgley 1998). All of the above commenters were of the opinion that if descendants of the sockeye salmon/kokanee hybrid stock still exist they should not be part of the Ozette Lake sockeye salmon ESU. Sones (1998) stated that progeny of this hybridization project did not survive, and Hoffman (1998) and Badgley (1998) stated that hybrids of the genetically distinct Ozette Lake sockeye salmon and kokanee would not be genetically similar to any wild fish in the ESU and should not be included in the Ozette Lake sockeye salmon ESU.

BRT Conclusions--Hatchery Populations

Ozette Lake (ESU 4)--The BRT concluded unanimously that the sockeye salmon stock reared at Umbrella Creek Hatchery should be considered part of the ESU, based on the fact that broodstock are derived from wild beach-spawning adults and the hatchery stock is not perpetuated by spawning fish returning to the hatchery. The BRT also unanimously concluded that the Umbrella Creek Hatchery stock is "not essential" for recovery. The opinion of the BRT on this second question was influenced by the presence of significant numbers of wild sockeye salmon still spawning on Olsen's Beach and in Allen's Bay in Ozette Lake, which could be used in recovery efforts.

The BRT also concluded unanimously that if progeny of the sockeye salmon/kokanee hybrid stock reared at Umbrella Creek Hatchery still exist, they should not be considered part of the ESU. This decision was based on the wide genetic divergence of Ozette Lake stream-spawning kokanee and beach-spawning sockeye salmon and the likelihood of hybrids of these stocks resembling neither of the native *O. nerka* stocks in Ozette Lake.

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TABLES

Table 1. Sockeye salmon evolutionarily significant units (ESUs) and their status as proposed by the National Marine Fisheries Service (NMFS 1998).

Status	ESUs
Proposed Threatened	
	Ozette Lake
Candidate	
	Baker River
Not proposed for listing	
	Okanogan River
	Lake Wenatchee
	Quinault Lake
	Lake Pleasant
Provisional ESU (not proposed for listing)	
	Big Bear Creek

Table 2. Organizations and individuals providing comments on the west coast sockeye salmon status review (Gustafson et al. 1997) and proposed rule (NMFS 1998).

Category	Organization/Person
Peer Reviewers	
	Chris C. Wood (Wood 1998)
	Ernest L. Brannon (Brannon 1998)
Federal Agencies	
	U.S. Department of the Interior (Taylor 1998)
State Agencies	
	Washington Department of Fish and Wildlife (Crawford 1998)
Tribal Agencies	
	Northwest Indian Fisheries Commission (Grayum 1998)
	Columbia River Inter-Tribal Fish Commission (Strong 1998)
	Confederated Tribes and Bands of the Yakama Indian Nation (Selam 1998)
Others	
	Green Crow Timber (Gladders 1998)
	Puget Sound Energy (Feldmann 1998)
	Rayonier Northwest Forest Resources (Meier 1998)
	Davis Wright Tremaine, LLP (Van Duzer 1998)
	Rochelle Environmental Forestry Consulting (Rochelle 1998)

Table 3. Collection information from literature sources (Guthrie et al. 1994; Wood et al. 1994; Winans et al. 1996; Waples et al. 1997) and from NMFS unpublished data for 9 polymorphic allozyme loci data set evaluated by NMFS for 12 North American river-/sea-type and 26 lake-type sockeye salmon. L = lake-type, R = river-type, R/S = river-/sea-type, S = sea-type.

Sample number and collection location		River Basin	Collection date	Life history type	Number of fish [a]	Source of data [b]
1	Redfish Lake (outmigrants)	Columbia	1991	L	138	1
2	Lake Wenatchee (juveniles)	Columbia	1988	L	120	2
3	Lake Osoyoos (Wells Dam)	Columbia	1990	L	63	2
4	Lake Pleasant [c]	Quillayute	1996	L	100	3
5	Ozette Lake (Allen's Bay) [c]	Ozette	1995	L	33	3
6	Quinault Lake (outmigrants) [c]	Quinault	1995	L	93	3
7	Cedar River 1994 [c]	L. Washington	1994	L	80	3
8	Big Bear Creek 1994 [c]	L. Washington	1994	L	80	3
9	Baker Lake	Skagit	1991	L	80	2
10	Sakinaw Lake	Sakinaw	1988	L	82-83	4
11	Babine Lake (Pierre Creek)	Skeena	1990	L	60	2
12	Lower Shuswap River	Fraser	1990	L	60	2
13	Klukshu Lake	Alsek	1992	L	75-76	4
14	Little Tatsamenie Lake	Taku	1990	L	67	5
15	Little Trapper Lake	Taku	1990	L	100	5
16	Tahltan Lake	Stikine	1982, 83, 85, 87	L	74-397	4
17	Meziadin Lake (Tintina Creek)	Nass	1986	L	95-100	4
18	Fred Wright Lake (Bonney Creek)	Nass	1984, 86, 87	L	90-279	4
19	Damdochax Lake	Nass	1984, 86, 87, 89	L	195-298	4
20	Great Central Lake	Vancouver Is.	1983, 90	L	100-243	4
21	Kennedy Lake	Vancouver Is.	1986	L	89-91	4
22	Cheewhat Lake	Vancouver Is.	1984	L	79-100	4
23	Weaver Channel	Fraser	1992	L	100	4
24	Chilko Lake	Fraser	1992	L	99	4
25	Quesnel Lake (Horsefly River)	Fraser	1985, 93	L	94-100	4
26	Shuswap Lake (Adams River)	Fraser	1990	L	100	4
27	Nooksack River [c,d]	Nooksack	1996	R	26	3
28	Sauk River [c]	Skagit	1996	R	15	3
29	Upper Skagit River [c]	Skagit	1996	R	25	3
30	Hackett River	Taku	1985, 87	R/S	57-91	4
31	Verrett River	Stikine	1983, 84, 85, 86, 89	R/S	216-691	4
32	Scud River	Stikine	1984 ,85, 87	R/S	83-211	4
33	Gingut Creek	Nass	1987, 88	S	93-168	4
34	Shustahini Creek	Taku	1986	R/S	97	5
35	Tuskwa Slough	Taku	1986	R/S	40	5
36	Yonakina Slough	Taku	1989	R/S	18	5
37	Chilkat River	Chilkat	1983	R/S	100	5
38	East Alsek River	East Alsek	1987	R/S	50	5

[a] Number of fish varies in some cases since not all fish were scored for each of the nine individual loci.

[b] Key to data sources: 1 - Waples et al. (1997), 2 - Winans et al. (1996), 3 - NMFS, unpublished, 4 - Wood et al. (1994), 5 - Guthrie et al. (1994).

[c] Washington Department of Fish and Wildlife provided tissues for Big Bear Creek 1994, Cedar River 1994, Nooksack River, Skagit River, Sauk River, and Lake Pleasant adults; the Makah Fisheries Management Department provided tissues for Ozette Lake-Allen's Bay; and the Quinault Indian Nation provided tissues from Quinault Lake.

[d] A pooled sample of adults from the North Fork and South Fork Nooksack Rivers.

Table 4. Summary of new population abundance and distribution information received.

ESU	Type of Information	Source
Ozette Lake		
	Updated adult abundance data	M. Crewson, Makah Indian Tribe (pers. comm., 21 August 1998)
Baker River		
	Updated adult abundance data	Sprague 1998
	Recent smolt migration data	G. Sprague, WDFW (pers. comm., 21 August 1998)
	Revised historical abundance analysis	Feldmann 1998
Other ESUs and Provisional ESU		
	Updated adult abundance data - Quinault Lake	D. Boyer, Quinault Indian Nation (pers. comm., 24 August 1998)
	Updated adult abundance data - Big Bear Creek	J. Ames, WDFW (pers. comm., 20 August 1998)
	Updated adult abundance data - Okanogan River and Lake Wenatchee	Fish Passage Center (1998)
	Updated adult abundance data - Lake Pleasant	E. Tierney, Quileute Indian Tribe (pers. comm., 20 October 1998)
Other populations		
	Updated adult abundance data - Lake Washington and Cedar River.	J. Ames, WDFW (pers. comm., 20 August 1998)
	Updated adult abundance data - Deschutes River, OR	K. Kostow, ODFW (pers. comm., 20 October 1998)

Table 5. Summary of recent status information for U. S. west coast sockeye salmon stocks. Blanks indicate insufficient data. Escapements are 5-yr geometric means (zeros recoded to 0.1); SR escapement is that reported in the status review (Gustafson et al. 1997), and last 5-yr escapement is for updated data (if any). Trends are average percent annual change estimated from log-linear regression. Asterisk (*) indicates that slope is significantly ($P<0.05$) different from zero.

ESU/Stock	Data Type	Data Years	S R Escapement	Last 5-yr Escapement	1986-95 Trend	Last 10-Yr Trend	Full Data Trend
ESUs							
Baker River	Trap Count	1926-98	2,700	7,600	31.6*	37.7*	-0.8
Ozette Lake	Weir Count	1977-98	700	580	-9.9	2.0	-2.0
Lake Pleasant	Spawner Survey	1987-97			-12.0	-8.7	-13.4
Quinault Lake	Hydro-acoustic	1967-97	32,000	30,600	-3.4	-3.0	1.1
Lake Wenatchee	Estim. Spawners	1961-98	19,000	6,300	-9.8	-21.1*	-0.9
Okanogan River	Spawner Survey	1977-93	23,000		-1.5		1.5
	Ladder Count	1960-98	11,100	7,000	-19.9*	-8.2	-2.9*
Snake River	Ladder Count	1970-98	6	3	-13.2	26.9	-19.1*
	Weir Count	1954-98	<1				
Provisional ESU							
Big Bear Creek	Spawner Survey	1982-97	11,400	12,600	-4.1	11.3	-3.4
Other Populations							
Cedar River	Spawner Count	1967-97	67,500	84,700	-18.2*	-8.2	-3.0*
L. Washington beaches	Spawner Count	1982-97	1,400	1,700	-9.6	-5.0	-11.5*
Sammamish River Tribs.	Spawner Count	1982-95	15,800		-4.6		-7.2
Deschutes River (Oregon)	Ladder Count	1957-98	8	5	-11.4	-17.4	-5.0

Table 6. Summary of BRT conclusions for extinction risk categories for sockeye salmon. The number in each cell denotes the number of BRT members voting for each risk level. The five-point scale used is described in Myers et al. (1998, Appendix E).

Ozette Lake Sockeye Salmon

	Risk Score					
	Lower Risk	----------	----------	----------	Higher Risk	
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution			8	3		3.3
Trends/Productivity			9	2		3.2
Genetic Integrity		9	2			2.2

Baker River Sockeye Salmon

	Risk Score					
	Lower Risk	----------	----------	----------	Higher Risk	
Risk Category	**1**	**2**	**3**	**4**	**5**	**Mean**
Abundance/Distribution	2	7	1			1.9
Trends/Productivity		6	4			2.4
Genetic Integrity	7	2	1			1.4

Table 7. Releases of sockeye salmon and hybrid sockeye salmon/kokanee juveniles from Umbrella Creek Hatchery [a]. Information on release location, comments, and all information for 1995-98 release years is new since the 1997 status review.

Brood year	Release year	Broodstock	Number released	Release location	Comments
1982	1983	Quinault Lake	120,000	Ozette Lake	
1983	1984	Ozette Lake beaches	10,000	Umbrella Creek	
1984	1985	--	0	--	no eggs available
1985	1986	Ozette Lake beaches	21,400	Umbrella Creek	
1986	1987	Ozette Lake beaches	12,400	Ozette Lake	
1987	1988	Ozette Lake beaches	15,000	Ozette Lake	
1987	1988	Ozette Lake beaches	118,300	Umbrella Creek	Accidentally released
1988	1989	Ozette Lake beaches	41,522	Ozette Lake	
1988	1989	Ozette Lake beaches	158,245	Umbrella Creek	Accidentally released; 131.000 reared for 5 d or less
1989	1990	--	0	--	Unable to capture broodstock
1990	1991	Ozette Lake beaches	9,504	Ozette Lake	
1990	1991	Siwash Creek and Ozette Lake beaches	2,915	Ozette Lake	hybridized female kokanee and male sockeye
1991	1992	Ozette Lake beaches	29,058	Ozette Lake	
1991	1992	Umbrella Creek	7,645	Umbrella Creek	broodstock from adults returning to hatchery
1991	1992	Siwash Creek and Ozette Lake beaches	11,483	Ozette Lake	hybridized female kokanee and male sockeye
1992	1993	?	0	--	entire lot destroyed due to IHN epizootic
1993	1994	Ozette Lake beaches	39,040	Ozette Lake	
1994	1995	Ozette Lake beaches	44,411	Ozette Lake	
1995	1996	Ozette Lake beaches	45,220	Umbrella Creek	
1996	1997	Ozette Lake beaches	209,562 56,733	Umbrella Creek Crooked Creek	
1997	1998	Ozette Lake beaches	139,220 48,536	Umbrella Creek Crooked Creek	
		Total sockeye	**1,140,194**		
		Total hybrids	**14,398**		

[a] Sources: Jacobs et al. (1996), MFMD (n. d.), and unpublished data provided by N. Currence for release years 1989-95 and D. Sones for release years 1995-1998.

FIGURES

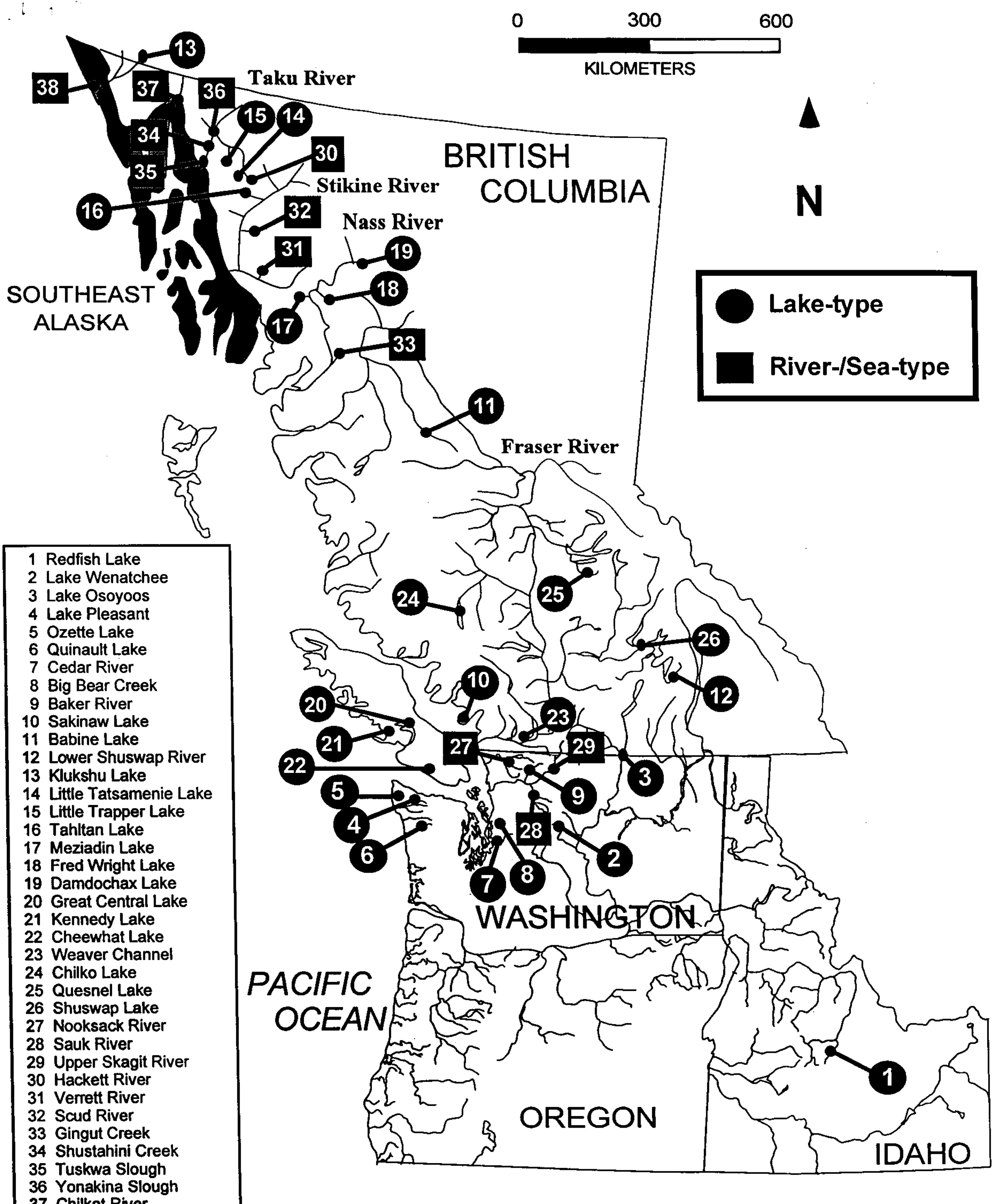

Figure 1. Collection locations for lake-type and river-/sea-type sockeye salmon allozyme samples in the Pacific Northwest, British Columbia, and Southeast Alaska. Data from Guthrie et al. (1994), Wood et al. (1994), Winans et al. (1996), Waples et al. (1997), and NMFS (unpublished).

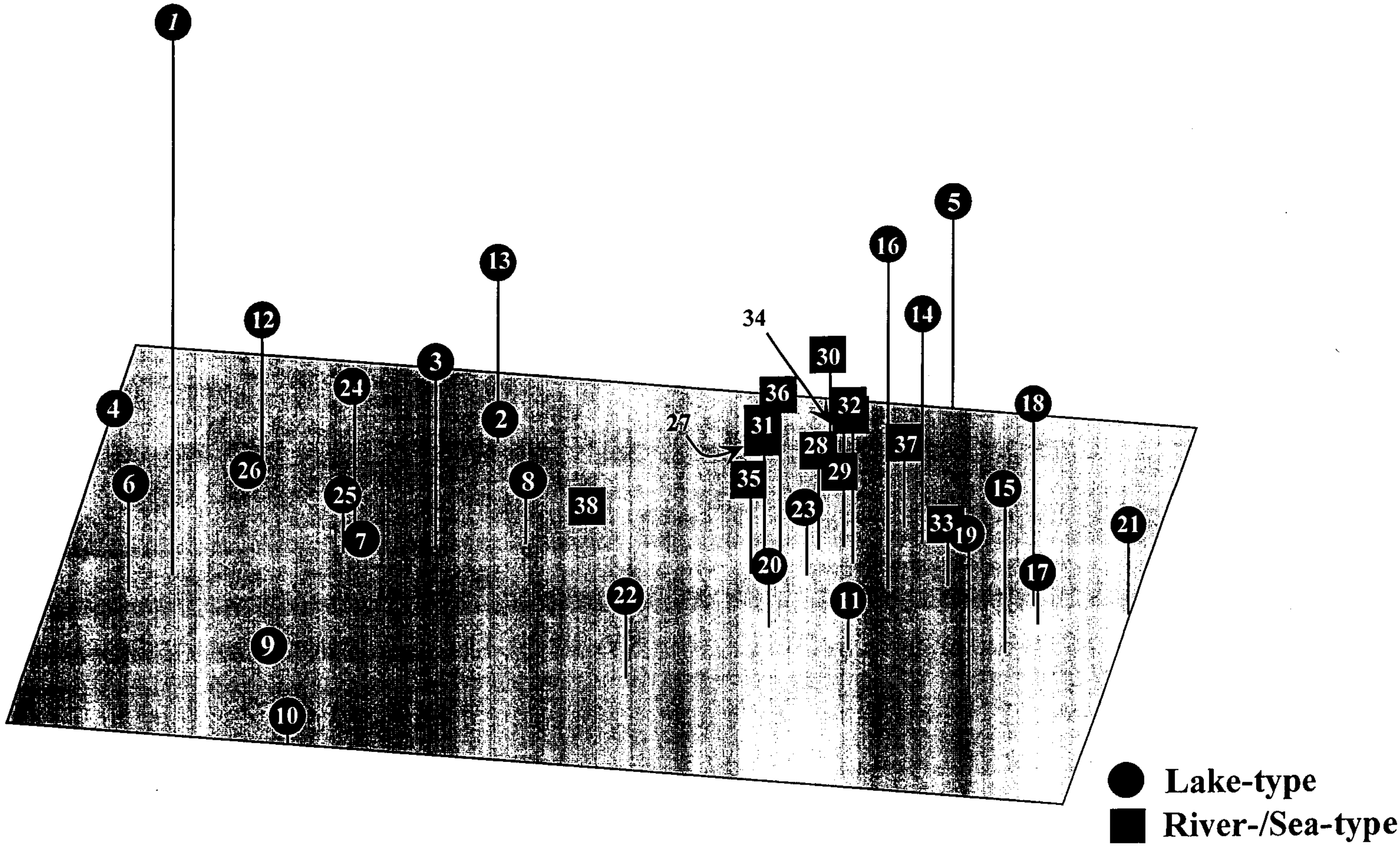

Figure 2. Multidimensional scaling (MDS) plot of Nei's (1978) genetic distance among 38 samples of lake-type and river-/sea-type sockeye salmon from the Pacific Northwest, British Columbia, and Southeast Alaska based on allele frequencies at 9 allozyme loci. Data from Guthrie et al. (1994), Wood et al. (1994), Winans et al. (1996), Waples et al. (1997), and NMFS (unpublished).

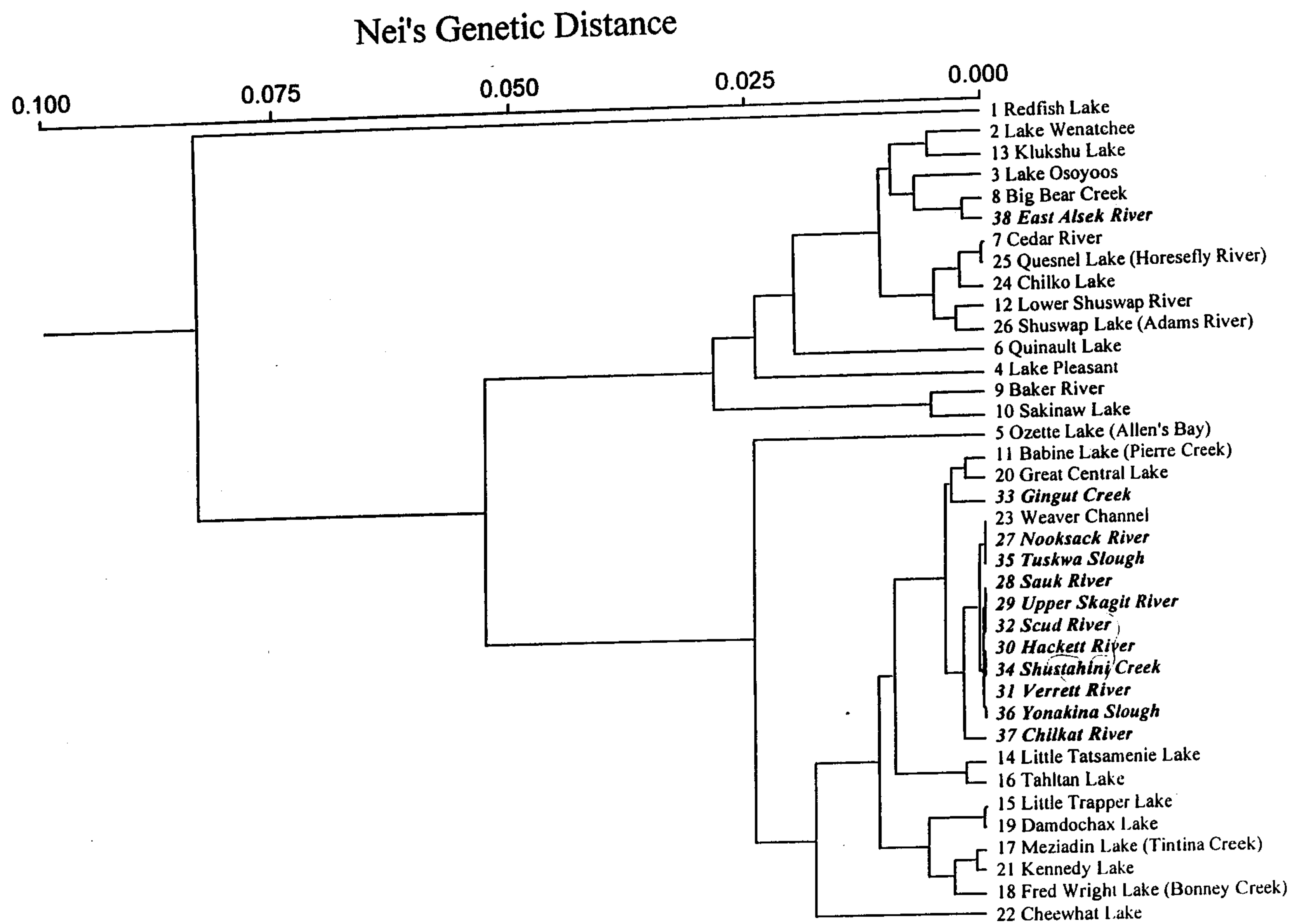

Figure 3. Dendrogram of Nei's (1978) unbiased genetic distances based on 9 allozyme loci in 38 samples of lake-type (regular type) and river-/sea-type (bold italic type) sockeye salmon from the Pacific Northwest, British Columbia, and Southeast Alaska. Data from Guthrie et al. (1994), Wood et al. (1994) Winans et al. (1996), Waples et al. (1997), and NMFS (unpublished).

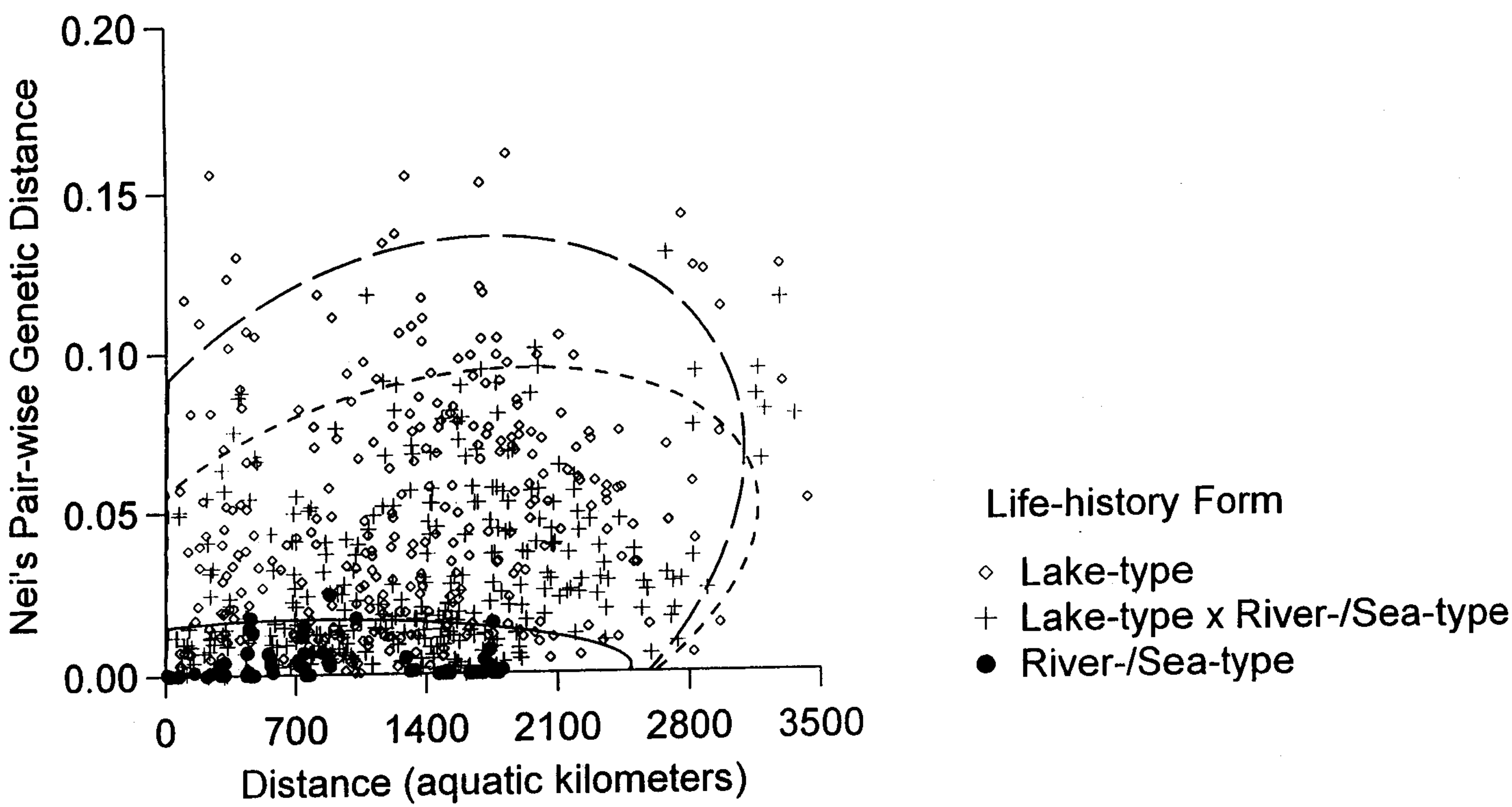

Figure 4. Plot of all pair-wise comparisons of Nei's (1978) genetic distance based on 9 allozyme loci and geographic distance (as aquatic kilometers) between all 703 possible pair-wise population comparisons. Comparisons are categorized as river-/sea-type by river-/sea-type, lake-type by river-/sea-type, and lake-type by lake-type. Ellipses represent the 95% percent confidence intervals of each relationship. Data from Guthrie et al. (1994), Wood et al. (1994), Winans et al. (1996), Waples et al. (1997), and NMFS (unpublished).

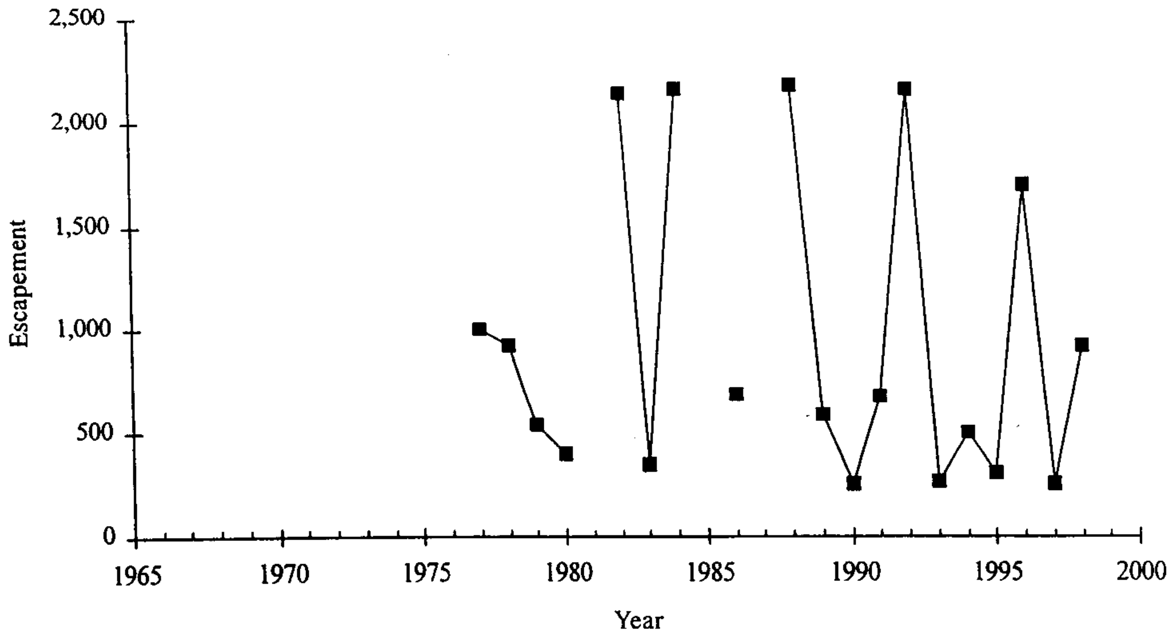

Figure 5. Estimated sockeye salmon escapement to the Ozette River, based on weir counts. Data from WDF et al. (1993), E. Currence, Makah Indian Tribe (pers. comm. October 1995), D. Dailey, Makah Indian Tribe (pers. comm. October 1996) and M. Crewson, Makah Indian Tribe (pers. comm, August 1998).

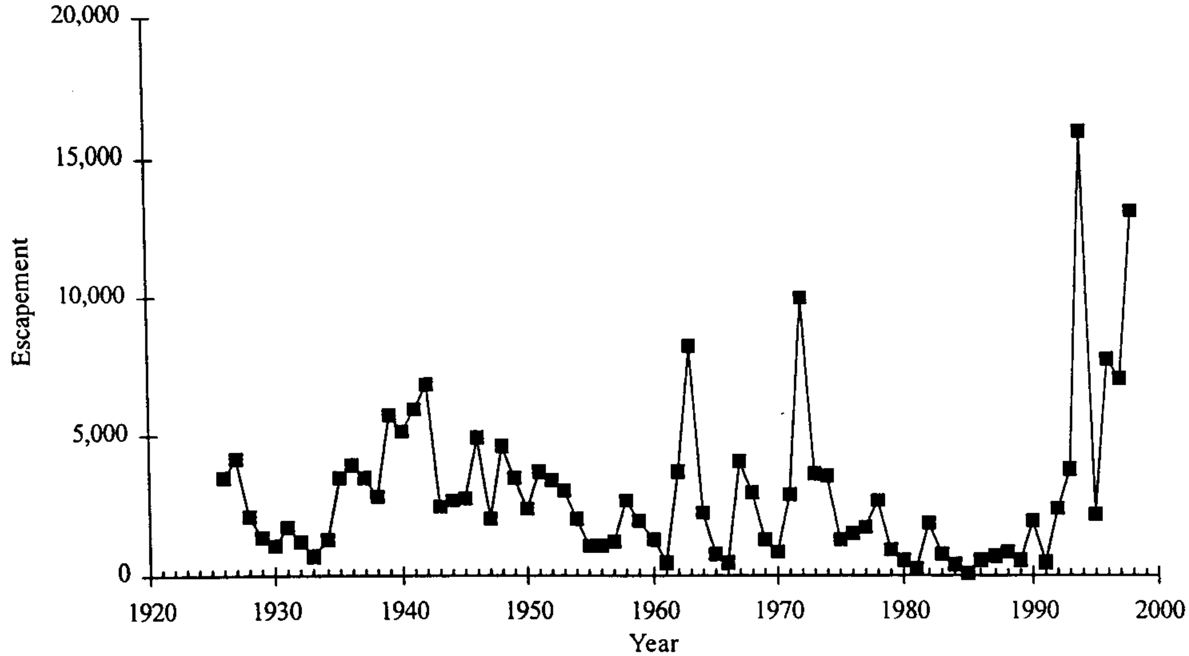

Figure 6. Estimated sockeye salmon escapement to the Baker River, based on trap counts. Data from CIS database (O'Connor et al. 1993), WDF et al. (1993), J. Ames, WDFW (pers. comm., March 1995, October 1996) and Sprague (1998).

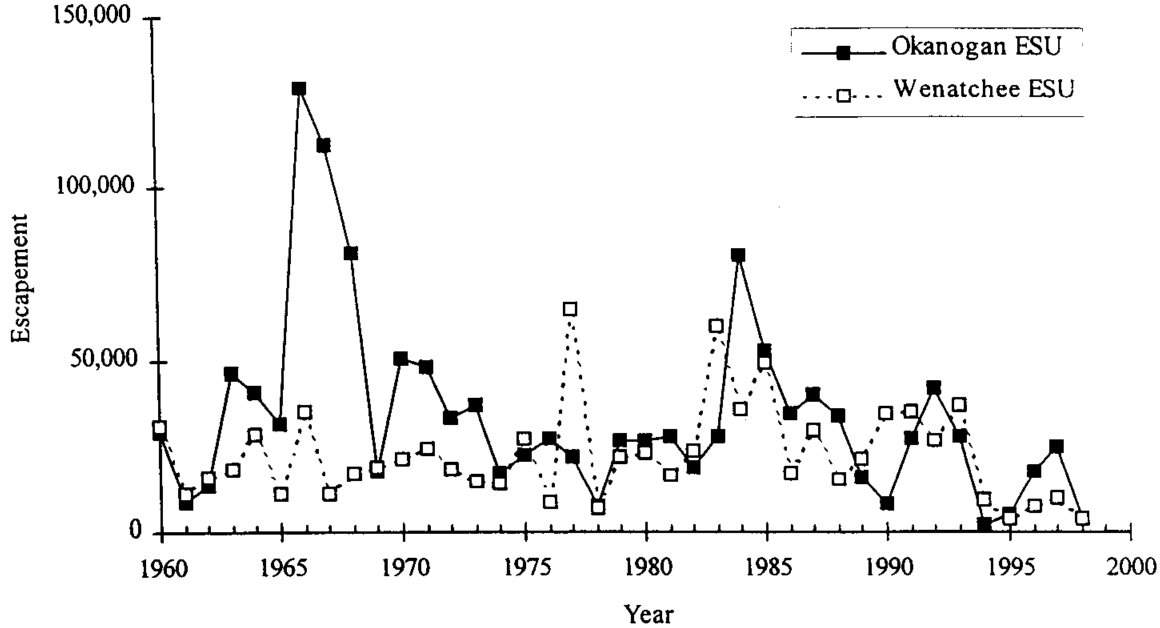

Figure 7. Estimated sockeye salmon escapement to the Okanogan River and Lake Wenatchee. Based on dam counts (TAC 1994, Fish Passage Center 1996, 1998).